Faraday Technology, Inc.
315 Huls Drive, Clayton, OH 45315
(937) 836-7749 http://www.faradaytechnology.com

Functional Trivalent Chromium Plating Process To Replace Hexavalent Chromium Plating

DESCRIPTION OF THE TECHNOLOGY

With support from the Environmental Protection Agency's (EPA) Small Business Innovation Research (SBIR) Program, Faraday Technology, Inc., has developed a cost-competitive functional trivalent chromium (Cr^{+3}) plating process to replace hexavalent chromium (Cr^{+6}). The pilot-scale technology is validating Faraday's electrically mediated Cr^{+3} plating process (the Faradaic™ Process) as a "drop-in" replacement for the use of Cr^{+6} plating. This manufacturing process validation is being executed with Moyno Industrial Products, a large manufacturer of industrial pumps, and the Naval Air Depot (NADEP) at Cherry Point, NC.

The process uses modulated reverse-current electrolysis in conjunction with a Cr^{+3} plating chemistry and results in a performance-based, functional Cr^{+3} plating process to replace conventional Cr^{+6} chromium plating. The process incorporates Faraday's E-CHANGE™ In-Process Recycling System (also developed under EPA SBIR Program funding) for effluent waste management. A controlled Alpha test of the Faradaic™ Process was completed in a pilot-scale manufacturing cell designed and built by Faraday. This test was conducted using strut rods provided by a Tier 1 automotive supplier.

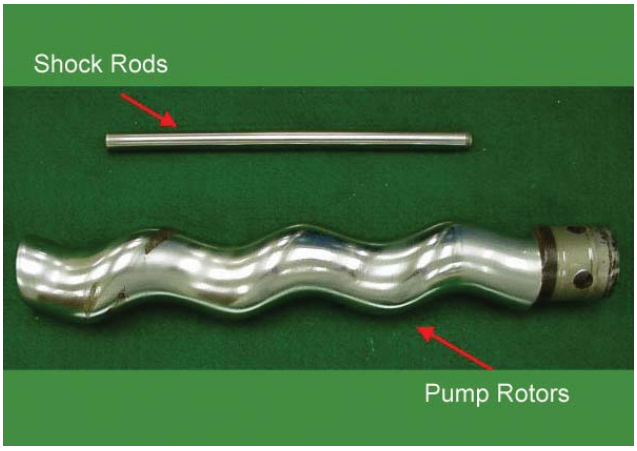
Faraday's functional Cr^{+3} plating process demonstrates equivalent or superior plating rate, hardness, and current efficiency; replaces the conventional Cr^{+6} plating process; and results in a more environmentally friendly and worker-safe plating process. The Faradaic™ Process demonstrates a thickness of 10 mils (250 m) and a plating rate of 1.44-2.25 µm/min; whereas, conventional Cr^{+6} plating processes demonstrate a thickness of 6-10 mils (150-250 m) and a plating rate of 0.76-1.27 µm/min.

SIGNIFICANCE OF THE TECHNOLOGY

EPA has identified Cr^{+6} as 1 of 17 "high-priority" toxic chemicals. These chemicals were selected based on their known health and environmental effects, production volume, and potential for exposure. Hexavalent plating baths operate at elevated temperatures and produce a mist of chromic acid. The Clean Air Act, as well as local constraints, regulate the emission of chromium to the air and water. Because Cr^{+6} plating produces hazardous air emissions, all of the Cr^{+6} platers must control and monitor the bath surface tension and report the results to EPA. In contrast, Cr^{+3} platers are not required to monitor bath surface tension. Use of Cr^{+3} in industrial and commercial processes is preferred over Cr^{+6} on the basis of the comparison of the toxicities. EPA has classified Cr^{+6} as a group A, known human carcinogen, and considers Cr^{+3} as being much less toxic and an essential element in the human diet. Cr^{+3} is classified by EPA as a Group D carcinogen, not classifiable as to carcinogenicity in humans.

SBIR Impact

- **Faraday Technology, Inc., developed a cost-competitive Cr^{+3} plating process to replace Cr^{+6} plating.**
- **The process uses a modulated reverse-current electrolysis in conjunction with a reduced-cost Cr^{+3} plating chemistry.**
- **Faraday's functional Cr^{+3} plating process demonstrates equivalent or superior plating rate, hardness, and current efficiency.**
- **To date, $219,723 in commercial revenue has been secured to support Faraday's pilot-scale activity.**



A pilot-scale plating Cr^{+3} line (left) is being operated at the Faraday facility in Clayton, OH. This plating line is a small-scale version of a shop-floor full-scale line. This line is being used to validate the Faradaic™ Process on shock rods and pump rotors (right).

The Faradaic™ Process is being widely implemented for:

- Faradaic™ Industrial Coatings, such as functional chromium from a trivalent chromium bath.
- Faradaic™ Edge and Surface finishing of advanced engineering alloys, such as stainless steel, aluminum, nickel, titanium, and the like without toxic, exotic electrolytes.
- Faradaic™ Leveling—metalization without leveler-brightener additives for advanced electronics applications.
- Faradaic™ Environmental Countermeasures—electrically mediated systems for in-process recycling of rinse waters and plating bath chemistry.

The functional Cr^{+3} plating process supports the Faradaic™ Process technologies listed above, by providing environmentally conscientious reclamation and reuse of process solutions.

COMMERCIALIZATION SUCCESS

To date, Faraday has secured $219,723 in commercial revenue to support this pilot-scale activity. Additionally, Faraday is preparing samples for external evaluation by Concurrent Technologies Corporation and NADEP Cherry Point. Faraday has a successful track record of technology commercialization, with six strategic technology alliances currently under contract and 60 percent of its annual sales coming from commercial sources. Faraday has filed patent application #08/871,599 titled, "Electroplating of Metals Using Pulse Reverse Current for Control of Hydrogen Evolution" based on this SBIR-funded project.

AWARDS AND COMPANY HISTORY

Faraday Technology, Inc., is an electrochemical process technology development company focused on enhancing and commercializing the Faradaic™ Process, its platform electrochemical manufacturing technology. Founded in 1991, Faraday has established itself as a noteworthy applied research and development company with approximately 80 publications and more than 30 patents/patents pending. The company has been recognized with a number of awards, including: the U.S. Small Business Administration-sponsored Small Business/Enterprise Spirit Awards, the State of Ohio Governor's Thomas Edison Emerging Technology Award, the Affiliate's Society Council of Dayton Outstanding Technology Leadership Award, the Abner Brenner Silver Medal Award for a paper published in *Plating & Surface Finishing*, and the Ernst & Young Entrepreneur of the Year Award (High Technology Finalist for 2001).

What is the SBIR Program?

EPA's Small Business Innovation Research (SBIR) Program was created to assist small businesses in transforming innovative ideas into commercial products. The SBIR Program has two phases—Phase I is the feasibility study to determine the validity of the proposed concept and Phase II is the development of the technology or product proven feasible in Phase I. EPA also offers Phase II Options to accelerate the commercialization of SBIR technologies and to complete EPA's Environmental Technology Verification (ETV) Program. For more information about EPA's SBIR Program and the National Center for Environmental Research, visit http://www.epa.gov/ncer/sbir.